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Stanley et al.

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(54) **ELEVATOR DISPATCH CONTROL TO AVOID PASSENGER CONFUSION**

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USPC 187/247, 380–389, 391–393
See application file for complete search history.

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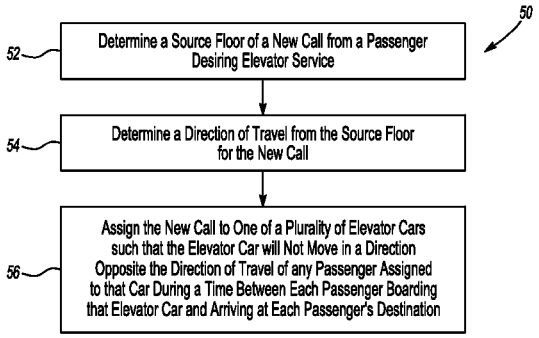
(57) **ABSTRACT**

An exemplary method of controlling an elevator system includes determining a source floor of a new call from a passenger desiring elevator service. A direction of travel from the source floor for the new call is also determined. A path of a considered elevator car is simulated as if the new call were assigned to the considered elevator car by determining at least one of (i) a relationship between a position of the considered elevator car and the source floor or (ii) a relationship between a direction of movement of the considered elevator car and the direction of travel. The new call is assigned to one of a plurality of elevator cars if the assigning will satisfy each of (i) the one of the elevator cars will not move in a direction opposite the direction of travel during a time between the passenger boarding the one of the elevator cars and arriving at a destination of the passenger and (ii) the one of the elevator cars will not move in a direction opposite a travel direction of any currently assigned passenger during a time between the currently assigned passenger boarding the one of the elevator cars and arriving at a destination of the currently assigned passenger.

17 Claims, 5 Drawing Sheets



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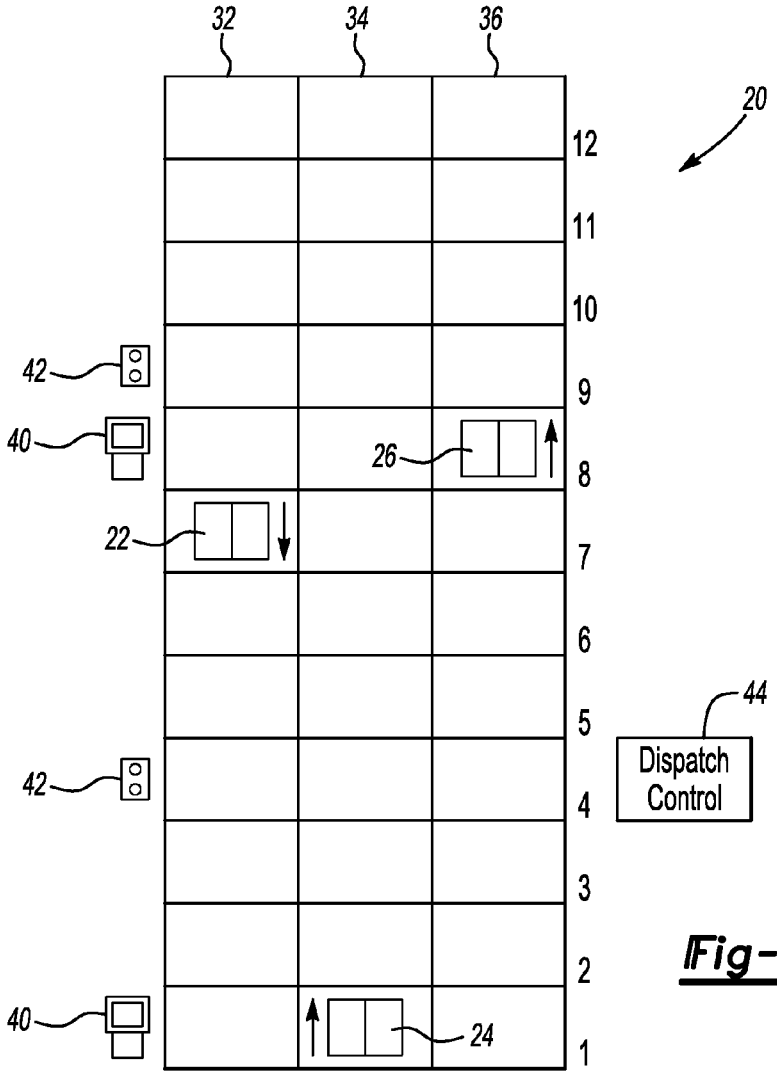

32
34
36
20
12
11
10
9
8
7
6
5
4
3
2
1
42
40
26
22
42
44
Dispatch Control
40
24

Fig-1

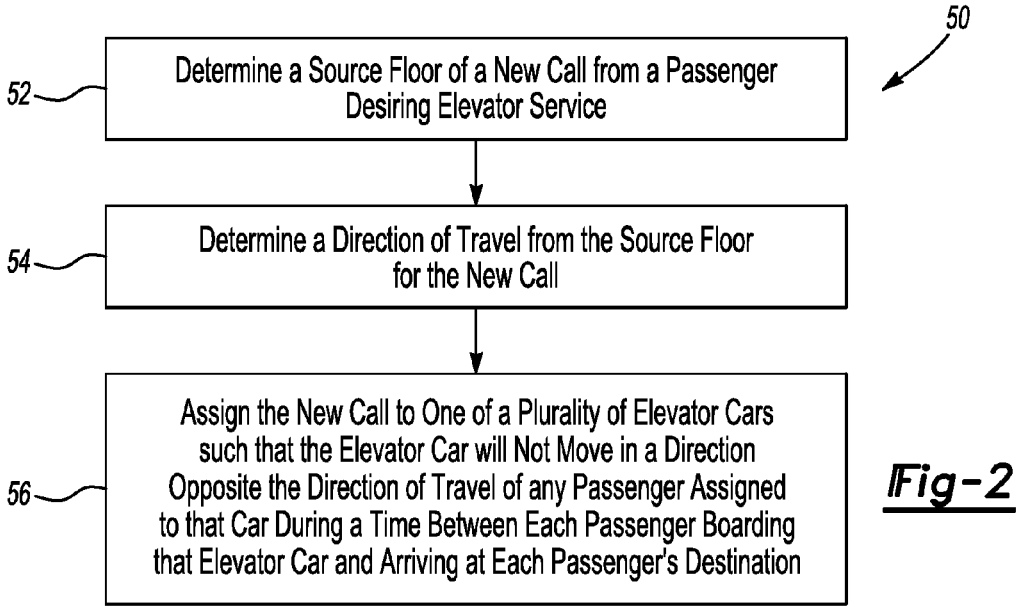

50
52
Determine a Source Floor of a New Call from a Passenger Desiring Elevator Service
54
Determine a Direction of Travel from the Source Floor for the New Call
56
Assign the New Call to One of a Plurality of Elevator Cars such that the Elevator Car will Not Move in a Direction Opposite the Direction of Travel of any Passenger Assigned to that Car During a Time Between Each Passenger Boarding that Elevator Car and Arriving at Each Passenger's Destination

Fig-2

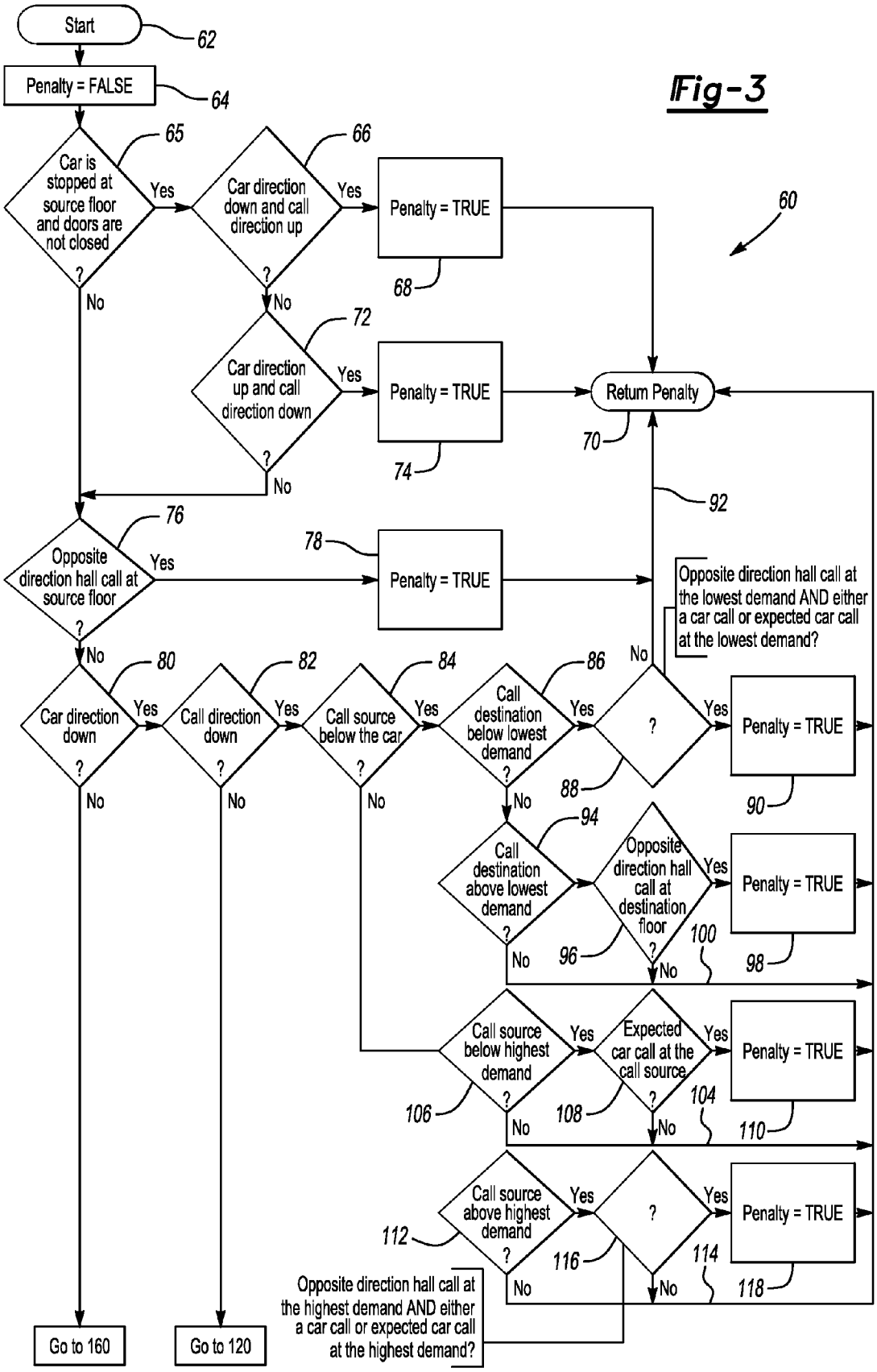
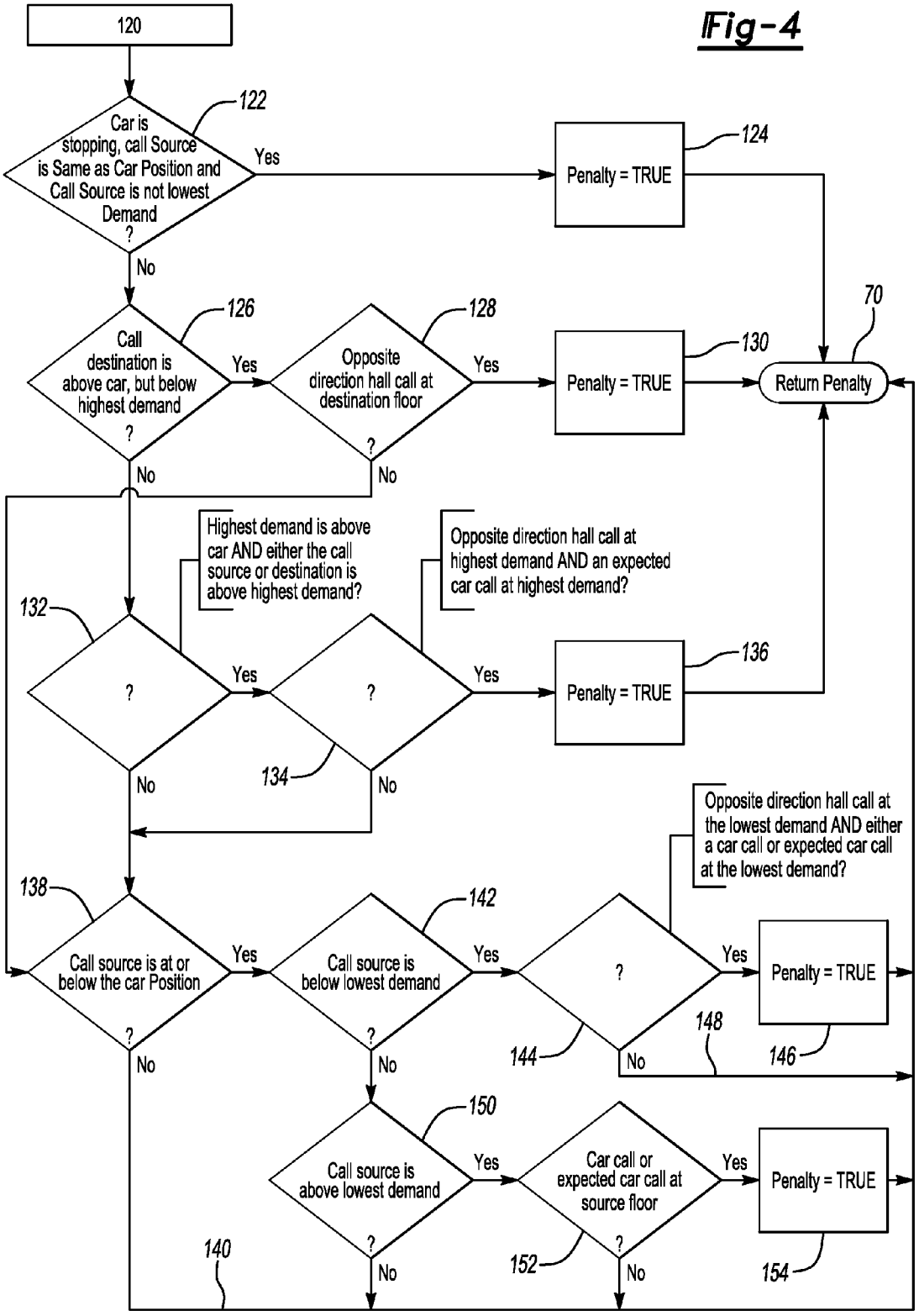

Start
62
Penalty = FALSE
64
Fig-3
60
65
Car is stopped at source floor and doors are not closed
Yes
66
Car direction down and call direction up
Yes
Penalty = TRUE
68
No
72
Car direction up and call direction down
Yes
Penalty = TRUE
74
Return Penalty
70
No
92
76
Opposite direction hall call at source floor
Yes
78
Penalty = TRUE
Opposite direction hall call at the lowest demand AND either a car call or expected car call at the lowest demand?
No
80
Car direction down
Yes
82
Call direction down
Yes
84
Call source below the car
Yes
86
Call destination below lowest demand
Yes
?
Yes
Penalty = TRUE
88
90
No
No
No
No
No
94
Call destination above lowest demand
Opposite direction hall call at destination floor
Yes
Penalty = TRUE
96
100
98
No
No
Call source below highest demand
Yes
Expected car call at the call source
Yes
Penalty = TRUE
106
108
104
110
No
No
Call source above highest demand
Yes
?
Yes
Penalty = TRUE
112
116
114
118
No
No
Opposite direction hall call at the highest demand AND either a car call or expected car call at the highest demand?
Go to 160
Go to 120

Fig-4


120
122
Car is stopping, call Source is Same as Car Position and Call Source is not lowest Demand ?
Yes
124
Penalty = TRUE
No
126
Call destination is above car, but below highest demand ?
Yes
128
Opposite direction hall call at destination floor ?
Yes
130
Penalty = TRUE
70
Return Penalty
No
No
Highest demand is above car AND either the call source or destination is above highest demand?
Opposite direction hall call at highest demand AND an expected car call at highest demand?
132
?
Yes
?
Yes
136
Penalty = TRUE
134
No
No
Opposite direction hall call at the lowest demand AND either a car call or expected car call at the lowest demand?
138
Call source is at or below the car Position ?
Yes
142
Call source is below lowest demand ?
Yes
?
Yes
Penalty = TRUE
148
144
No
146
No
No
150
Call source is above lowest demand ?
Yes
Car call or expected car call at source floor ?
Yes
Penalty = TRUE
140
No
152
No
154

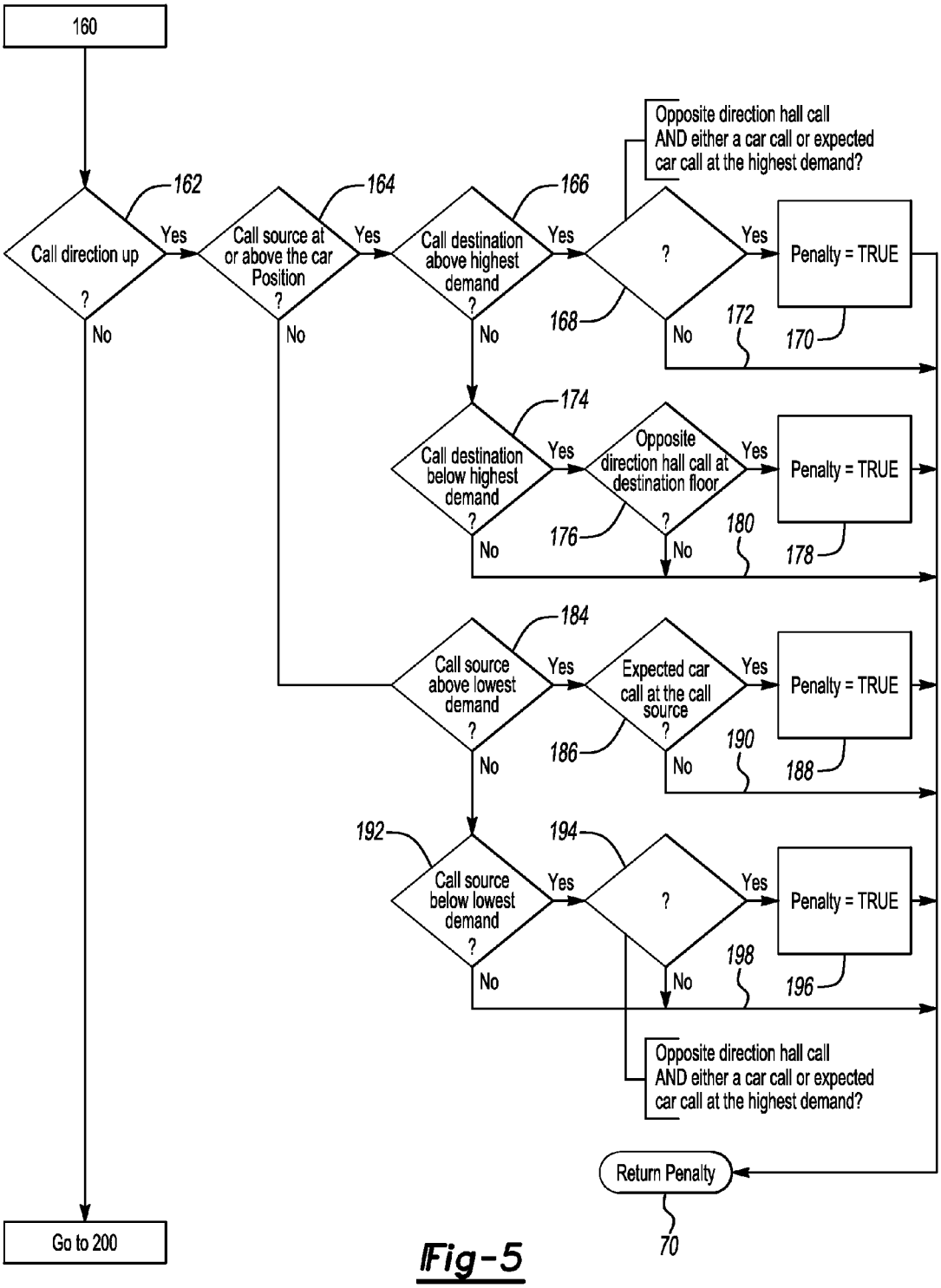
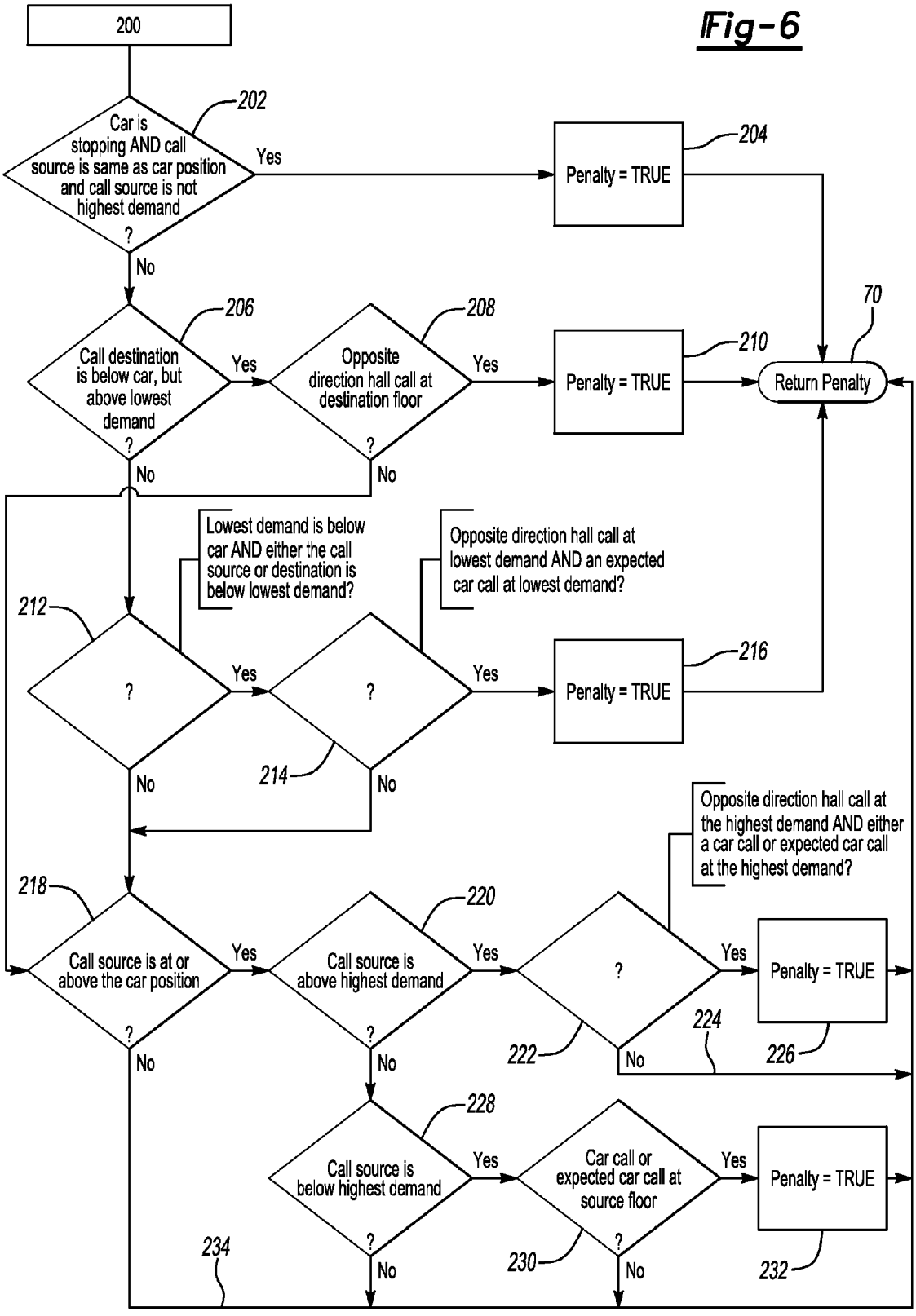

160
Call direction up ?
Yes
No
162
Call source at or above the car Position ?
Yes
No
164
Call destination above highest demand ?
Yes
No
166
Opposite direction hall call AND either a car call or expected car call at the highest demand?
?
Yes
No
168
172
Penalty = TRUE
170
174
Call destination below highest demand ?
Yes
No
Opposite direction hall call at destination floor ?
Yes
No
176
180
Penalty = TRUE
178
184
Call source above lowest demand ?
Yes
No
Expected car call at the call source ?
Yes
No
186
190
Penalty = TRUE
188
192
Call source below lowest demand ?
Yes
No
194
?
Yes
No
198
Penalty = TRUE
196
Opposite direction hall call AND either a car call or expected car call at the highest demand?
Return Penalty
70
Go to 200

Fig-5

Fig-6


200
202
Car is stopping AND call source is same as car position and call source is not highest demand
?
Yes
No
204
Penalty = TRUE
206
Call destination is below car, but above lowest demand
?
Yes
No
208
Opposite direction hall call at destination floor
?
Yes
No
210
Penalty = TRUE
70
Return Penalty
Lowest demand is below car AND either the call source or destination is below lowest demand?
Opposite direction hall call at lowest demand AND an expected car call at lowest demand?
212
?
Yes
No
?
Yes
No
214
216
Penalty = TRUE
Opposite direction hall call at the highest demand AND either a car call or expected car call at the highest demand?
218
Call source is at or above the car position
?
Yes
No
220
Call source is above highest demand
?
Yes
No
?
Yes
No
222
224
Penalty = TRUE
226
228
Call source is below highest demand
?
Yes
No
Car call or expected car call at source floor
?
Yes
No
230
Penalty = TRUE
232
234

ELEVATOR DISPATCH CONTROL TO AVOID PASSENGER CONFUSION

BACKGROUND

Elevator systems are in widespread use for carrying passengers between various levels in buildings, for example. For many years elevator systems operated based upon hall calls initiated by a passenger pressing a hall call button indicating a desire to be carried up or down from a particular floor. Many such elevator systems include hall lanterns that indicate a direction of movement of an elevator car arriving at a particular landing. The hall lanterns allow a passenger to determine whether they desire to get on a particular car based, in part, on whether that car is heading in the direction that passenger desires to travel.

Modern elevator systems may include a variety of different technologies for allowing passengers to place a call for elevator service. For example, destination entry systems allow a passenger to provide an indication of their intended destination floor before the passenger enters an elevator car. With such systems, a dispatch controller assigns a particular car to service that call. While such systems allow for improved efficiencies in traffic capacity, especially for larger buildings, they introduce certain difficulties in some situations.

For example, many destination entry systems do not have hall lanterns at the entrances to the cars, but instead have some other car indicator to allow a passenger to know which car they are supposed to take. Without a hall lantern indicating the direction that the car is moving, a passenger may get on a car expecting it to go in one direction when, in fact, it will travel in the opposite direction. This can be a source of confusion for passengers.

Such a situation is particularly problematic when a car arrives at the landing where the passenger expects to board an elevator car but that car is not yet traveling in the direction of that passenger's destination. It is possible for the passenger to enter that car and travel in the wrong direction. The car subsequently returns to the landing where the passenger already boarded the car. At that location the system expects the passenger to board the car and uses some sort of sensor for detecting whether somebody entered the car. As the passenger has previously boarded the car, the system assumes that passenger is not there and may cancel the passenger's intended destination. That passenger ends up confused and possibly frustrated because of what appears to the passenger as a malfunction of the elevator system.

SUMMARY

An exemplary method of controlling an elevator system includes determining a source floor of a new call from a passenger desiring elevator service. A direction of travel from the source floor for the new call is also determined. A path of a considered elevator car is simulated as if the new call were assigned to the considered elevator car by determining at least one of (i) a relationship between a position of the considered elevator car and the source floor or (ii) a relationship between a direction of movement of the considered elevator car and the direction of travel. The new call is assigned to one of a plurality of elevator cars if the assigning will satisfy each of (i) the one of the elevator cars will not move in a direction opposite the direction of travel during a time between the passenger boarding the one of the elevator cars and arriving at a destination of the passenger and (ii) the one of the elevator cars will not move in a direction opposite a travel direction of any currently assigned passenger during a time between the currently assigned passenger boarding the one of the elevator cars and arriving at a destination of the currently assigned passenger.

The various features and advantages of an example embodiment will become apparent to those skilled in the art from the following detailed description. The drawings that accompany the detailed description can be briefly described as follows.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** schematically shows selected portions of an example elevator system.

FIG. **2** is a flowchart diagram summarizing one example approach.

FIG. **3** is a flowchart diagram summarizing an example algorithm for determining which of a plurality of elevator cars will be assigned a particular call.

FIG. **4** is a flowchart diagram showing further details regarding a portion of the example of FIG. **3**.

FIG. **5** is a flowchart diagram showing further details of a portion of the example of FIG. **3**.

FIG. **6** is a flowchart diagram showing further details of the example of FIG. **5**.

DETAILED DESCRIPTION

FIG. **1** schematically shows selected portions of an example elevator system **20**. A plurality of elevator cars **22**, **24** and **26** are situated for carrying passengers between different building levels schematically shown as levels **1**-**12** in FIG. **1**. Each of the elevator cars **22**, **24** and **26** is in a hoistway **32**, **34** and **36**, respectively. Only three elevator cars are shown for purposes of discussion. Example implementations of this invention can be utilized for any number of elevator cars depending on the needs of a particular situation.

The example of FIG. **1** includes destination entry devices **40** that are configured to allow passengers to request elevator service. The destination entry devices **40** include a passenger interface that allows the passenger to indicate a desired destination while the passenger is outside of an elevator car (e.g., while still in the elevator lobby). Such devices are known. FIG. **1** includes another example passenger input device comprising hall call buttons **42**. Hall call buttons allow a passenger at a particular building level to indicate a desire to be carried up or down from that level. Such devices are known.

The example of FIG. **1** includes a dispatch controller **44** that assigns one of the elevator cars **22**, **24** or **26** to particular calls depending on a variety of factors. The dispatch controller **44** in this example makes car assignments that minimize the possibility for passenger confusion or frustration by preventing or minimizing the occurrence of a situation in which a passenger boards an elevator car that is headed in a direction opposite to the direction the passenger needs to travel to reach that passenger's intended destination.

FIG. **2** is a flowchart diagram **50** summarizing one example approach. At **52**, the dispatch controller **44** determines a source floor of a new call from a passenger desiring elevator service. At **54** a direction of travel from the source floor for the new call is determined. The direction of travel is the direction in which the passenger needs to go to reach the intended destination. The new call may be placed using a variety of types of passenger input devices such as one of the destination entry devices **40** or hall call buttons **42**. At **56** the dispatch controller **44** assigns the new call to one of the elevator cars such that the elevator car will not move in a direction opposite the direction of travel for the new call or any currently

assigned passenger for that car during a time between each passenger boarding that car and arriving at the passenger's respective destination.

By avoiding a situation in which a passenger will be carried in the direction opposite to the direction they need to travel to reach their intended destination, the disclosed example avoids passenger confusion and frustration. Additionally, the situation in which an elevator controller may mistakenly determine that the passenger has not boarded the elevator car and responsively cancels the request can be avoided.

While there are a variety of algorithms useful for controlling the elevator system **20** so that the dispatch controller **44** makes an assignment according to the example approach summarized in FIG. **2**, a particular algorithm is summarized in the flowcharts of FIGS. **3-6**. The example flowchart **60** begins in FIG. **3** where the dispatch algorithm is initiated at **62**. In this example the algorithm simulates a path of the elevator car under consideration if the new call were assigned to that elevator car. A determination is made whether a condition will exist in which the elevator car travels in a direction opposite to the direction that the passenger placing the new call needs to travel to reach the intended destination. If so, a different one of the elevator cars is considered.

In some examples, it may not be possible to assign the call to any one of the cars without at least some travel in an opposite direction. Under such circumstances, a variety of criteria may be used to select the best one of the elevator cars based upon factors such as shortest wait time, minimum amounts of travel in the opposite direction, minimizing a number of stops for the elevator car or minimizing total elevator car movement, for example. Those skilled in the art who have the benefit of this description will be able to select appropriate criteria to deal with such a situation.

In the example of FIG. **3**, a penalty value is initiated at **64**. The penalty value in this example indicates whether a candidate car could be assigned the new call. In this example, when the penalty value is FALSE, that indicates that there is no penalty associated with assigning the new call to a particular elevator car. If so, that elevator car is an appropriate candidate to be assigned the new call. Of course, additional criteria may be utilized to select the best of any available candidate cars for a particular new call. The algorithm summarized in the flowchart **60** is intended to simulate the car travel path for each of the considered elevator cars to determine whether it is an appropriate candidate for call assignment. The details of how to select from among more than one available candidate car, if there is more than one, is outside the scope of this disclosure.

A determination is made at **65** whether a candidate elevator car is stopped at the source floor where the new call will originate. In other words, the determination at **65** determines whether a particular elevator car is stopped at the floor from which the passenger desires to board an elevator car. The determination at **65** includes determining whether the car doors are open. As indicated at **66**, if the car is stopped at the source floor and the doors are opened, a determination is then made whether the car direction of movement is down and the direction associated with the new call is up. If so, the penalty value is set to TRUE at **68**. As soon as the penalty value is TRUE for a particular elevator car, that is returned or reported at **70**. In this example, the penalty value of TRUE disqualifies an elevator car from being a candidate for assignment of the new call.

Assuming that the determination at **66** is negative, another determination is made at **72** regarding whether the car direction is up and the call direction is down. If so, the penalty value is set to TRUE at **74**. This is then returned or reported at **70**.

Assuming the determination at **65** is negative, the next step in the example of FIG. **3** is shown at **76**. As can be appreciated from the drawing, the decision at **76** will also be made if the determination at **65** was positive and the determinations at **66** and **72** were negative. At **76**, a determination is made whether a hall call at the source floor already exists that requires the car to travel in a direction opposite to that of the new call under consideration. If so, the penalty value is set to TRUE at **78** and that is reported at **70**. If the determination at **76** results in a negative conclusion, a decision is made at **80** whether the car direction is down. This car direction is the current direction of movement of the elevator car under consideration. Assuming that it is, another determination is made at **82** whether the direction associated with the new call is also down.

Based upon a positive conclusion at **82**, a determination whether the call source is below the current position of the car is made at **84**. This is based upon determining the source floor for the new call and the current position of the elevator car under consideration, for example. Assuming that the call source floor is below the elevator car, a determination is made at **86** whether the call destination is below the lowest demand of the current assignments to that particular elevator car. If so, another determination is made at **88** whether there are any opposite direction hall calls at the lowest demand and there is either a current car call or an expected car call at the lowest demand of that elevator car's current run based on current assignments to that car.

When the determination at **88** includes a positive conclusion, that elevator car is not eligible to service that call and the penalty value is set to TRUE at **90**. If, on the other hand, the determination at **88** results in a negative conclusion, the penalty value is still FALSE and the algorithm moves along the path shown at **92** where the penalty value is then reported at **70**. Under these latter circumstances, the elevator car under consideration is a valid candidate to receive an assignment of the new call under consideration.

Previously a positive outcome at **86** was considered but now assume that the determination made at **86** results in a negative conclusion. The next step in the illustrated example is shown at **94** where a determination is made whether the call destination is above the lowest demand of the elevator car's current run assignments. If so, another determination at **96** includes considering whether there is an opposite direction hall call at the destination floor. When there is, that elevator car is not a valid candidate for the new call and the penalty value is set to TRUE at **98**.

If the determination made at **94** or **96** results in a negative conclusion, the example algorithm follows the path shown at **100** and the penalty value of FALSE is reported at **70**. Under either of those circumstances, the elevator car is a valid candidate and could be assigned the new call.

The previous discussion assumed that the determination at **84** resulted in a positive conclusion. Assume now that the call source is not below the car and that the conclusion at **84** is negative. Then a determination is made at **106** whether the call source is below the highest demand floor for that elevator car given the current assignments to that car. If so, a determination is made at **108** whether an expected car call exists at the source floor where the new call originates. If so, the penalty is set to TRUE at **110** and that elevator car is not eligible for assignment of the new call. If the determination at **108** is that there is no expected car call at the source of the new call, then the example algorithm follows the path at **104** and the FALSE value for the penalty is reported at **70**. Under that circum-

stance, the elevator car under consideration is a valid candidate for assignment of the new call.

Assume now that the determination at **106** results in a negative conclusion because the call source is not below the highest demand. Then a determination whether the call source is above the highest demand is made at **112**. If not, the algorithm follows the path at **114** and the FALSE value for the penalty is reported at **70**. If the call source is above the highest demand as determined at **112**, then a determination at **116** is made. This determination is whether there is an opposite direction hall call at the highest demand for that car and there is a car call or an expected car call at the highest demand. If the determination at **116** involves a negative conclusion, the path at **114** is followed to report the FALSE value of the penalty. If, on the other hand, the determination at **116** results in a positive conclusion, then the penalty is set to TRUE at **118** and that elevator car is not an eligible candidate for assignment of the new call.

The discussion above assumed that the determination made at **82** resulted in a positive conclusion (i.e., that the car direction was down and the call direction was down). Assume now that the determination at **82** results in a negative conclusion because the call direction is up while the car direction as determined at **80** is down. Under these circumstances, the steps summarized in FIG. **4** will be followed as indicated by the connector **120** in FIG. **3**.

As shown in FIG. **4**, a determination is made at **122** whether the elevator car under consideration is stopping, the source of the new call is the same as the car position and the call source is not equal to the lowest demand. If so, the penalty value is set to TRUE at **124** and then reported at **70**. If the conditions at **122** are not satisfied, then a determination is made at **126** whether the destination of the new call is above the car but below the highest demand on the car given the car's current assignments. If so, then a determination is made at **128** whether there is an opposite direction hall call at the destination floor. When the determination at **128** yields a positive result, the penalty value is set to TRUE at **130** and then returned at **70**.

If the determination made at **126** yields a negative result, then a determination is made at **132** whether the highest demand is above the car and either the call source or the destination of the new call is above the highest demand. If so, the example at FIG. **4** proceeds to **134** where a determination is made whether there is an opposite direction hall call at the location of the highest demand and an expected car call at the highest demand. If so, then the penalty value is set to TRUE at **136**.

If the determinations made at any one of **128**, **132** or **134** yields a negative result, then a decision is made at **138** whether the call source is at or below the car's position. If not, the algorithm proceeds along the path shown at **140** to return the penalty value of FALSE, which means that the elevator car is a valid candidate for possible assignment of the new call. On the other hand, when the call source is at or below the car's position as determined at **138**, the next determination is made at **142** to determine if the call source is below the lowest demand. When it is, a determination is made at **144** whether there is an opposite direction hall call at the lowest demand and a car call or an expected car call is also at the lowest demand. When those conditions are met, the penalty value is set to TRUE at **146**. When the determination at **144** yields a negative result, the penalty value of FALSE is reported because the path at **148** is followed up to the penalty reporting step **70**.

Referring back to the decision at **142**, when the call source is not below the lowest demand of the elevator car, the next determination is made at **150** whether the call source is above the lowest demand. If not, the path at **140** is followed and the penalty value FALSE is reported at **70**. When, on the other hand, the call source is above the lowest demand, a determination at **152** indicates whether there is a car call or an expected car call at the source floor of the new call. If so, the penalty value is set to TRUE at **154**. If the determination at **152** yields a negative result, then the path at **140** is followed and the penalty value of FALSE is reported at **70** because the elevator car under consideration is a candidate for assignment of the new call.

Each of the steps followed in FIG. **4** were undertaken under the assumption that the determination at **80** in FIG. **3** yielded a positive result and the determination at **82** yielded a negative result. Under some circumstances, the determination made at **80** whether the car direction is down will be negative because the car is heading upward. Under these conditions, the determinations shown in the flowchart of FIG. **5** will be undertaken by following the path to the connector **160**.

In FIG. **5** the first determination is shown at **162**. At this point a determination is made whether the call direction is up, which would mean the call direction is the same as the car direction in this example. If so, a determination at **164** indicates whether the call source is at or above the car's position. If yes, the next step is to determine at **166** whether the call destination is above the highest demand on the car given the car's current assignments. When the call destination is above that highest demand, a determination is made at **168** whether there is an opposite direction hall call and either a car call or an expected car call at the highest demand. If so, the penalty value is set to TRUE at **170**. When the determination at **168** yields a negative result, the example of FIG. **5** follows the path shown at **172** and the penalty value of FALSE is reported at **70**. That condition indicates that the elevator car under consideration is a valid candidate for assignment of the new call.

Looking back to the decision at **166**, if the call destination is not above the highest demand, a determination is made at **174** whether the call destination is below the highest demand. If it is, a determination at **176** indicates whether there is an opposite direction hall call at the destination floor. If so, the penalty value is set to TRUE at **178** and that is reported at **70**. If the determination made at **174** or **176** yields a negative result, the car under consideration is a valid candidate for assignment of the new call and the path at **180** in FIG. **5** would be followed.

The steps **166-178** would be undertaken if the determination at **164** yielded a positive result. When, however, the call source is not above the car as determined at **164**, the next determination is made at **184** whether the call source is above the lowest demand. When the result at **184** is positive, a decision is made at **186** whether there is an expected car call at the call source floor. If so, the penalty value is set to TRUE at **188**. If, on the other hand, the determination made at **186** yields a negative result, the path at **190** would be followed and the penalty value of FALSE would be reported at **70**.

When the determination at **184** regarding the call source being above the lowest demand yields a negative result, the illustrated example proceeds to **192**. Here a determination is made whether the call source is below the lowest demand on the elevator car. If so, a determination at **194** indicates whether there is an opposite direction hall call and either a car call or an expected car call at the lowest demand. When those conditions are satisfied, the penalty value is set to TRUE at **196** and the car is not considered eligible for the new call. If, on the other hand, the determination made at **192** or **194**

yields a negative result, the path shown at **198** would be followed and the elevator car would be considered a valid candidate for that new call.

The steps **164-196** shown in FIG. **5** would be followed according to the above description when the determination at **162** indicates that the call direction is up. If, on the other hand, the call direction is down, the example algorithm proceeds to the connector **200** so that the procedure summarized in FIG. **6** provides an indication of car eligibility for assignment.

As shown in FIG. **6**, assuming a negative determination at **162** (FIG. **5**) a determination is made at **202** is whether the car is stopping, the call source is the same floor as the car position and the call source is not the highest demand. If so, the penalty value is set to TRUE at **204** and reported at **70**. If, on the other hand, the conditions at **202** are not satisfied, then a determination is made at **206** whether the call destination is below the car but above the lowest demand on the car. If so, a determination is made at **208** whether there is an opposite direction hall call at the destination floor. When that is the case, the penalty value is set to TRUE at **210**. The elevator car would not be considered a valid candidate at that point and the penalty value is returned at **70**.

When the determination at **206** yields a negative result, another determination at **212** is made whether the lowest demand on the car is below the car and either the call source or the destination of the new call is below that lowest demand. When those conditions are met, a determination is made at **214** whether there is an opposite direction hall call and there is an expected car call at the lowest demand location. Under those conditions, the penalty value is set to TRUE at **216**.

If the determination made at **208**, **212** or **214** yields a negative result, the next step in the illustrated example is shown at **218**. At this point a determination is made whether the call source is at or above the car's position. When it is, the determination at **220** indicates whether the call source is above the highest demand. When the decision at **220** yields a positive result, a determination is made at **222** whether there is an opposite direction hall call along with either a car call or an expected car call at the highest demand. When those conditions are satisfied, the elevator car should not be considered a valid candidate for assignment of the new call and the penalty value is set to TRUE at **226**. When the determination at **222** yields a negative result, on the other hand, the penalty value is still FALSE and that is reported at **70** by following the path indicated at **224**.

Looking back to the decision at **220**, when the call source is not above the highest demand, the illustrated example includes a decision at **228** regarding whether the call source is below the highest demand. When it is, another decision at **230** indicates whether the car call or an expected car call exists at the source floor. If so, the penalty value is set to TRUE at **232**. When the determination made at **230**, **228** or **218** yields a negative result, the path shown at **234** in FIG. **6** would be followed to report the penalty value of FALSE at **70**. Under any of those conditions, the elevator car under consideration could be assigned the new call.

As one example scenario, assume that a new call is placed on floor **8** in FIG. **1** using the destination entry device **40**. The new call includes an indication from the passenger that the desire is to travel up to floor **12**. For purposes of discussion, the elevator car **22** is currently at floor **7** and traveling downward to the first floor with no intermediate stops. The elevator car **24** is traveling from the first floor up to the seventh floor with an intermediate stop at floor **5**. The elevator car **26** is currently stopped at floor **8** with its doors open for purposes of answering a hall call in the up direction. The passenger placing that hall call enters the car **26** and indicates a desire to travel to floor **10**.

Now considering the example algorithm summarized in FIGS. **3-6**, the elevator car **22** is considered first. Beginning at **62** in FIG. **3**, the penalty value for car **22** is currently set at FALSE according to the step **64**. The determination at **65** yields a negative result because the car is not stopped at the source floor. The next step is **76** where a determination is made whether there is an opposite direction hall call at the source floor. The result of that inquiry is negative and a determination is made at **80** whether the car direction is down. The elevator car **22** is currently traveling from floor **7** to the first floor. So the answer to the inquiry at **80** is yes and the determination is made at **82** whether the call direction is down. In this example, the call direction would be up as the passenger desires to go from floor **8** to floor **12**. Accordingly, the connector **120** is followed into FIG. **4**. The determination at **122** is negative because the car is not stopping and the call source is not the same as the car position. The next determination at **126** yields a negative result because the call destination of the new call is above the car but not below the highest demand on the car. This would require following the flow of FIG. **4** to the step **132**. The result of that determination would be negative because the highest demand on the car **22** is not above the car. This would lead to the determination at **138** where a determination is made whether the call source is below the car. In this example, the call source is floor **8** and the elevator car **22** is currently at floor **7**. Therefore, the determination at **138** would be negative and the penalty value remains FALSE, which is reported at **70**. In other words, the elevator car **22** is a valid candidate for assignment of the new call because assigning the call to it would not result in an opposite direction of movement of the elevator car **22** from the direction of travel required by the passenger placing the new call during the time between when the passenger would board the elevator car **22** and arrive at the destination floor **12**. Under the example scenario, the elevator car **22** will return to the first floor before the passenger on floor **8** could board the car. The car **22** could then travel upward to handle the new call.

Considering the car **24** and starting with the determination at **65** in FIG. **3**, the car **24** is not stopped at the source floor. Therefore, the next determination is made at **76** where the question must be answered whether there is an opposite direction hall call at the source floor. Under the assumed circumstances, there is not so the next inquiry is made at **80**. The direction of the elevator car **24** is up, therefore, the result would be to go to the connector **160** and proceed with the algorithm in FIG. **5**. The next determination would be whether the call direction is up as shown at **162**. The answer to that question is yes so the next determination is whether the call source is above the car at **164**. Given that the call sources is floor **8** and the car **24** is at the first floor, the result of the determination at **164** is positive. The next question is answered at **166** whether the call destination is above the highest demand on the car **24**. The answer to that question is yes. The next determination is made at **168** whether an opposite direction hall call is at the highest demand (e.g., floor seven) and there is either a car call or an expected car call at the highest demand. The answer to that question under the assumed circumstances is no and the path shown at **172** would be followed. In other words, the elevator car **24** is a valid candidate for assignment of the new call in this scenario.

Turning to the elevator car **26** and referring to FIG. **3**, the determination at **65** yields a positive result because the car **26** is stopped at the source floor of the new call and the car doors are currently opened. The next determination is made at **66** whether the car direction is down and the call direction is up. Given that the elevator car **26** is moving up, the answer is no and the next determination must be made at **72**. In this case, the car direction is up and the call direction is up so that a negative result occurs at the determination made at **72**. This requires following the path to the determination at **76**. Given the assumed scenario, there is no opposite direction hall call at the eighth floor. The next determination is then made at **80** whether the car direction is up or down. In this case, the car **26** is moving up so the flow continues to the connector at **160**. The determination is then made at **162** (FIG. **5**) whether the call direction is up. Given that the passenger desires to go from floor eight to floor twelve, the answer to the inquiry at **162** is yes.

A determination at **164** indicates whether the call source is at or above the car's position. Given that the car and the call source are both on the eighth floor, a positive result takes the flow to the determination at **166**. In this case, the call destination is in fact above the highest demand, which yields a positive result. The flow continues to the connector **168** where a determination is made whether an opposite direction hall call along with either a car call or expected car call exists at the current highest demand. Since only a car call exists, the answer to that question is no and the path shown at **172** would be followed to report the FALSE penalty value at **70**. The elevator car **26** is a valid candidate for the new call.

Given that all three example cars could be assigned the new call, other criteria will be used to choose one of those cars. Under the given circumstances according to one example, it is most likely to assign the new call to the elevator car **26** because that will provide the shortest wait time for the passenger. The car **26** is already on the eighth floor and the passenger could conceivably board that car immediately. If for some reason it would appear not likely that the passenger could board that car (e.g., the car is already fully loaded), the elevator car **24** is likely the next best choice because it is likely to arrive at the eighth floor to pick up the passenger placing the new call before the elevator car **22** could get there. Other criteria may be used to select between available candidate cars. Given this description, those skilled in the art will be able to arrange appropriate criteria to meet their particular needs for such situations.

If any of the cars **22**, **24** or **26** were situated such that the corresponding penalty value for that car were set to TRUE when following the path of the illustrated flowcharts, that car would be eliminated from consideration and not be a candidate car. Such a car would travel in a direction opposite the direction of travel required by the new call between the time when the passenger would board that car and arrive at the new call destination.

The illustrated example provides a technique of controlling an elevator system in a manner that avoids passenger confusion and frustration by reducing or eliminating opposite travel conditions during which a passenger would enter an elevator car and be carried in a direction opposite the direction they expect to travel to reach their desired destination.

The preceding description is exemplary rather than limiting in nature. Variations and modifications to the disclosed examples may become apparent to those skilled in the art that do not necessarily depart from the essence of this invention. The scope of legal protection given to this invention can only be determined by studying the following claims.

We claim:

1. A method of controlling an elevator system, comprising the steps of:

determining a direction of travel from a source floor of a new call from a passenger desiring elevator service;

simulating a path of a considered elevator car if the new call were assigned to the considered elevator car by determining at least one of the following relationships:

(i) a relationship between a position of the considered elevator car and the source floor or

(ii) a relationship between a direction of movement of the considered elevator car and the direction of travel; and

assigning the new call to one of a plurality of elevator cars if the assigning will satisfy each of

(i) the one of the elevator cars will not move in a direction opposite the direction of travel during a time between the passenger boarding the one of the elevator cars and arriving at a destination of the passenger, and

(ii) the one of the elevator cars will not move in a direction opposite a travel direction of any currently assigned passenger during a time between the currently assigned passenger boarding the one of the elevator cars and arriving at a destination of the currently assigned passenger.

2. The method of claim **1**, comprising

assigning the new call to the one of the plurality of elevator cars if the assigning will not result in the one of the elevator cars stopping at a source floor of the currently assigned passenger and subsequently moving in a direction opposite a direction from the source floor of the currently assigned passenger to the destination of the currently assigned passenger.

3. The method of claim **2**, comprising

determining at least one of

whether either the source floor of the new call or the destination of the new call is either above or below either a highest demand or a lowest demand on a considered elevator car;

whether a considered elevator car has a call waiting at either the source floor or the destination;

whether a considered elevator car has a hall call waiting at the source floor, the hall call having a direction of movement opposite the direction of travel; or

whether a considered elevator car has a call or an expected call waiting at either a highest demand on the considered elevator car or a lowest demand on the considered elevator car.

4. The method of claim **1**, comprising

determining whether a considered elevator car is at the source floor;

determining whether the considered elevator car will move in a direction opposite the direction of travel; and

designating the considered elevator car as ineligible for assignment of the new call when the considered elevator car is at the source floor and will move in the direction opposite the direction of travel.

5. The method of claim **1**, comprising

determining whether the direction of travel is the same as a direction of movement of a considered elevator car; and

determining whether the source floor is above or below the considered elevator car.

6. The method of claim **5**, wherein the direction of travel is the same as the direction of movement of the considered elevator car, the method comprising

designating the considered elevator car as a candidate for assignment of the new call when the source floor is not

below the considered elevator car and the source floor is not above the considered elevator car.

7. The method of claim 5, wherein the direction of travel and the direction of movement are both down and the source floor is below the considered elevator car, the method comprising

determining whether the destination of the new call is above or below a lowest demand on the considered elevator car; and

at least one of

(i) designating the considered elevator car as a valid candidate for assignment of the new call if the destination of the new call is not below or above the lowest demand;

(ii) designating the considered elevator car as a valid candidate for assignment of the new call if the destination of the new call is below the lowest demand and either there is no opposite direction hall call at the lowest demand or there is no car call or expected car call at the lowest demand;

(iii) designating the considered elevator car as ineligible for assignment of the new call if the destination of the new call is below the lowest demand and there is an opposite direction hall call at the lowest demand and there is a car call at the lowest demand or an expected car call at the lowest demand;

(iv) designating the considered elevator car as a valid candidate for assignment of the new call if the destination of the new call is above the lowest demand and there is no opposite direction hall call at the destination of the new call; or

(v) designating the considered elevator car as ineligible for assignment of the new call if the destination of the new call is above the lowest demand and there is an opposite direction hall call at the destination of the new call.

8. The method of claim 5, wherein the direction of movement and the direction of travel are both down and the source floor is above the considered elevator car, the method comprising

determining whether the source floor is above or below a highest demand on the considered elevator car; and

at least one of

(i) designating the considered elevator car as a valid candidate for assignment of the new call if the source floor of the new call is not below or above the highest demand;

(ii) designating the considered elevator car as a valid candidate for assignment of the new call if the source floor of the new call is below the highest demand and there is no expected car call at the source floor;

(iii) designating the considered elevator car as ineligible for assignment of the new call if the source floor of the new call is below the highest demand and there is an expected car call at the source floor;

(iv) designating the considered elevator car as a valid candidate for assignment of the new call if the source floor of the new call is above the highest demand and there is either no opposite direction hall call at the highest demand or no car call at the highest demand or no expected car call at the highest demand; or

(v) designating the considered elevator car as ineligible for assignment of the new call if the source floor of the new call is above the highest demand and there is an opposite direction hall call at the highest demand and there is either a car call or an expected car call at the highest demand.

9. The method of claim 5, wherein the direction of travel and the direction of movement are both up and the source floor is at or above the considered elevator car, the method comprising

determining whether the destination of the new call is above or below a highest demand on the considered elevator car; and

at least one of

(i) designating the considered elevator car as a valid candidate for assignment of the new call if the destination of the new call is not below or above the highest demand;

(ii) designating the considered elevator car as a valid candidate for assignment of the new call if the destination of the new call is below the highest demand and there is no hall call at the destination, the hall call having a direction opposite the direction of travel;

(iii) designating the considered elevator car as ineligible for assignment of the new call if the destination of the new call is below the highest demand and there is a hall call at the destination, the hall call having a direction opposite the direction of travel;

(iv) designating the considered elevator car as a valid candidate for assignment of the new call if the destination of the new call is above the highest demand and there is no hall call at the highest demand on the considered elevator car, the hall call having a direction opposite the direction of travel or there is no car call at the highest demand or there is no expected car call at the highest demand; or

(v) designating the considered elevator car as ineligible for assignment of the new call if the destination of the new call is above the highest demand and there is a hall call at the highest demand on the considered elevator car, the hall call having a direction opposite the direction of travel and there is a car call or an expected car call at the highest demand.

10. The method of claim 5, wherein the direction of travel and the direction of movement are both up and the source floor is below the considered elevator car, the method comprising

determining whether the source floor is above or below a lowest demand on the considered elevator car; and

at least one of

(i) designating the considered elevator car as a valid candidate for assignment of the new call if the source floor of the new call is not below or above the lowest demand;

(ii) designating the considered elevator car as a valid candidate for assignment of the new call if the source floor of the new call is above the lowest demand and there is no expected car call at the source floor;

(iii) designating the considered elevator car as ineligible for assignment of the new call if the source floor of the new call is above the lowest demand and there is an expected car call at the source floor;

(iv) designating the considered elevator car as a valid candidate for assignment of the new call if the source floor of the new call is below the lowest demand and either there is no hall call at the lowest demand, the hall call having a direction opposite the direction of travel or there is no car call at the lowest demand or there is no expected car call at the lowest demand; or

(v) designating the considered elevator car as ineligible for assignment of the new call if the source floor of the new call is below the lowest demand and there is a hall call at the lowest demand, the hall call having a direction opposite the direction of travel and there is either a car call or an expected car call at the lowest demand.

11. The method of claim 5, wherein the direction of travel is different than the direction of movement, the method comprising at least one of

designating the considered elevator car a valid candidate for assignment of the new call if the source floor is above the considered elevator car when the direction of travel is up and the direction of movement is down;

designating the considered elevator car a valid candidate for assignment of the new call if the source floor is below the considered elevator car when the direction of travel is down and the direction of movement is up.

12. The method of claim 5, wherein the direction of travel is up, the direction of movement is down and the source floor is below the considered elevator car, the method comprising

determining whether the source floor is above or below the lowest demand on the considered elevator car; and

at least one of

(i) designating the considered elevator car a valid candidate for assignment of the new call if the call source is not below the lowest demand and not above the lowest demand;

(ii) designating the considered elevator car a valid candidate for assignment of the new call if the source floor is below the lowest demand and there is no hall call at the lowest demand, the hall call having a direction opposite the direction of travel, or there is no car call or no expected car call at the lowest demand;

(iii) designating the considered elevator car ineligible for assignment of the new call if the source floor is below the lowest demand and there is a hall call at the lowest demand, the hall call having a direction opposite the direction of travel, and there is either a car call or an expected car call at the lowest demand;

(iv) designating the considered elevator car a valid candidate for assignment of the new call if the source floor is above the lowest demand and there is no car call or no expected car call at the source floor; or

(v) designating the considered elevator car ineligible for assignment of the new call if the source floor is above the lowest demand and there is a car call or an expected car call at the source floor.

13. The method of claim 5, wherein the direction of travel is down, the direction of movement is up and the source floor is above the considered elevator car, the method comprising

determining whether the source floor is above or below the highest demand on the considered elevator car; and

at least one of

(i) designating the considered elevator car a valid candidate for assignment of the new call if the call source is not below the lowest demand and not above the highest demand;

(ii) designating the considered elevator car a valid candidate for assignment of the new call if the source floor is above the highest demand and there is no hall call having a direction opposite the direction of travel or there is no car call at the highest demand or no expected car call at the highest demand;

(iii) designating the considered elevator car ineligible for assignment of the new call if the source floor is above the highest demand and there is a hall call having a direction opposite the direction of travel, and there is either a car call at the highest demand or an expected car call at the highest demand;

(iv) designating the considered elevator car a valid candidate for assignment of the new call if the source floor is below the highest demand and there is no car call or no expected car call at the source floor; or

(v) designating the considered elevator car ineligible for assignment of the new call if the source floor is below the highest demand and there is a car call or an expected car call at the source floor.

14. The method of claim 1, comprising

determining that the direction of travel and a direction of movement of a considered elevator car are different; and

designating the considered elevator car as ineligible for assignment of the new call if the considered elevator car is stopping at a source floor of the new call.

15. The method of claim 1, comprising

determining that the direction of travel and a direction of movement of a considered elevator car are different;

determining whether the destination of the new call is either

(a) above the considered elevator car and below a highest demand on the considered elevator car or

(b) below the considered elevator car and above a lowest demand on the considered elevator car; and

designating the considered elevator car as ineligible for assignment of the new call if there is a hall call at the destination, the hall call having a direction opposite the direction of travel, and the destination satisfies the conditions of (a) or (b).

16. The method of claim 1, comprising

determining that the direction of travel and a direction of movement of a considered elevator car are different;

determining whether the destination of the new call is either

(i) above the considered elevator car and below a highest demand on the considered elevator car or

(ii) below the considered elevator car and above a lowest demand on the considered elevator car; and

at least one of

designating the considered elevator car as ineligible for assignment of the new call if (a) a lowest demand on the considered elevator car is below the considered elevator car and either the source floor or the destination is below the lowest demand and (b) there is a hall call at the lowest demand, the hall call having a direction opposite the direction of travel, and there is an expected car call at the lowest demand; or

designating the considered elevator car as ineligible for assignment of the new call if (a) a highest demand on the considered elevator car is above the considered elevator car and either the source floor or the destination is above the highest demand and (b) there is a hall call at the highest demand, the hall call having a direction opposite the direction of travel, and there is an expected car call at the highest demand.

17. An elevator system, comprising:

a plurality of elevator cars;

at least one passenger input device configured to allow a passenger to place a new call for elevator service; and

a dispatch controller configured to

determine a direction of travel from a source floor of a new call from a passenger desiring elevator service;

simulate a path of a considered elevator car if the new call were assigned to the considered elevator car by determining at least one of the following relationships:

(i) a relationship between a position of the considered elevator car and the source floor or

(ii) a relationship between a direction of movement of the considered elevator car and the direction of travel; and

assign the new call to one of the plurality of elevator cars if the assigning will satisfy each of

(i) the one of the elevator cars will not move in a direction opposite the direction of travel during a time between the passenger boarding the one of the elevator cars and arriving at a destination of the passenger, and

(ii) the one of the elevator cars will not move in a direction opposite a travel direction of any currently assigned passenger during a time between the currently assigned passenger boarding the one of the elevator cars and arriving at a destination of the currently assigned passenger.

* * * * *